REMARKS

Claims 1-11 are pending in the application. Claims 1-11 are rejected. Claims 1, 2, 4, 7-9 are amended herein. The rejections are respectfully traversed. No new matter is added.

Claim 1 is amended to make the claim more definite according to the Examiner's Response to Arguments in the Final Rejection mailed on January 14, 2005.

Claims 2, 4, 7 and 8 are amended to correct clerical errors.

The present invention has been examined in Office Actions dated September 9, 2004, and January 11, 2005. Now, in an Advisory Action the Examiner requests further clarification related to linear discriminant analysis.

Linear discriminant analysis (LDA), is also known as Fisher's linear discriminant, after its inventor, Ronald A. Fisher, see present Specification line 15, at page 10.

Requiring the claims to include the details of how linear discriminant analysis operates would be akin to requiring the details of a Fourier transform in a claim that recites an FFT. Fisher first published his seminal work on LDA as "The use of multiple measures in taxonomic problems," Annals of Eugenics, Vol. 7, pp. 179-188, 1936. Thus, LDA has been known in the prior art for almost 70 years.

Those of ordinary skill in the art would readily understand how to perform an LDA on observation samples.

LDA is typically used as a feature extraction step. This is what is claimed. The feature extraction takes place before a classification step, as with the present application. LDA predict the probability of a binary random class variable c (feature) from given a vector of observations **x** (the extended vector) .

Simply explained, LDA is based on the following observation. If densities

$$p(\vec{x} | c = 1) \text{ and } p(\vec{x} | c = 0)$$

are both normally distributed, with identical full-rank covariances, but possibly different means, then a sufficient statistic for $P(c|\vec{x})$ is given by

$$\vec{x} \otimes \vec{w},$$

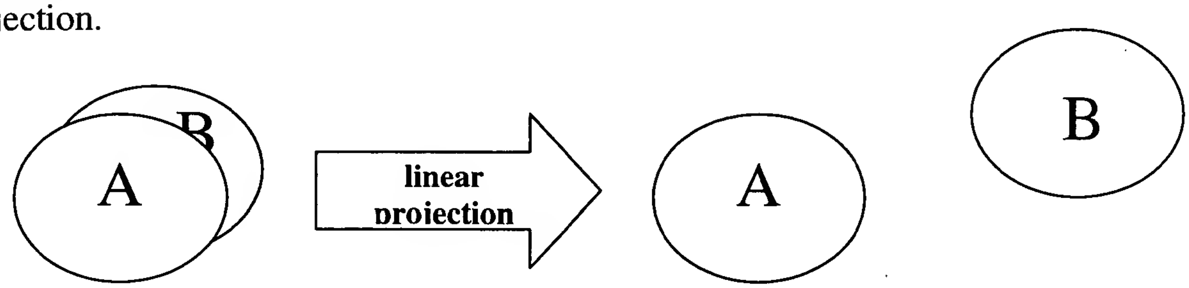
where "$\otimes$" is a dot product that performs the *linear combining* or **linear projection**, and $\vec{w}$ is a rectangular matrix that maximizes the separation between the feature classes, i.e., $\vec{w}$ is the inverse covariance matrix of the observations:

$$\vec{w} = \sum^{-1}(\vec{\mu}_1 - \vec{\mu}_0).$$

That is, the probability of an input observation **x** being in a class c is purely a function of this dot product, linear projection.

A property of this projection is that, out of all possible one-dimensional projections, this one maximizes the distance between the projected means to the variance of the projected normal distributions. Thus, in some sense, this projection maximizes the separation of the features into classes, see Specification line 17 at page 10, " The classes that are used for the LDA 330 are the same as the phones modeled by the recognizer. Linear discrimination analysis maximally separates the classes."

This can be illustrated as follow. Consider features A and B before and after projection.

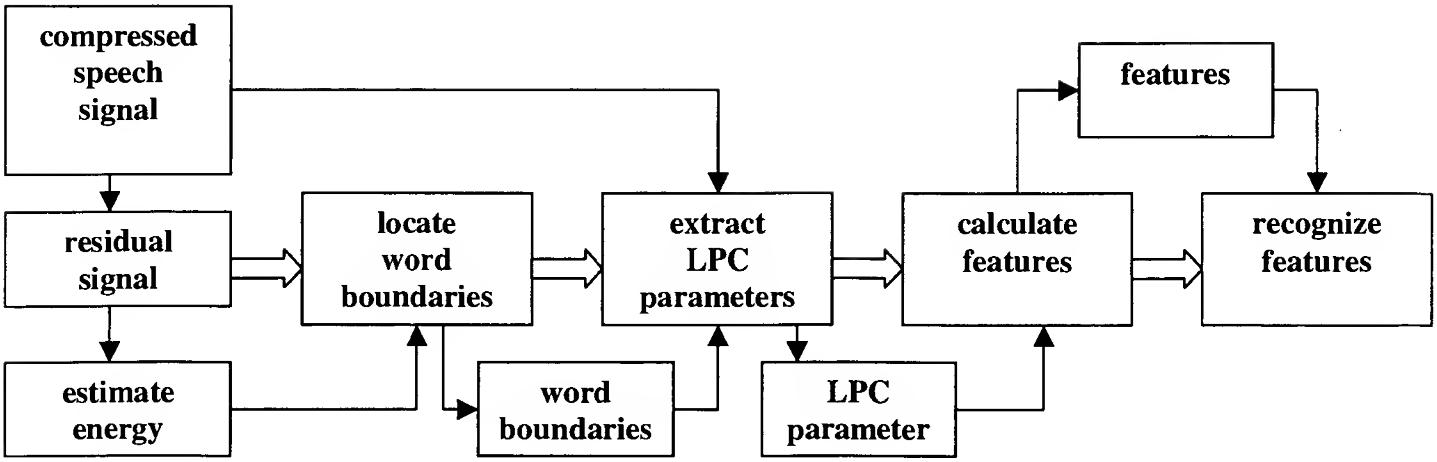


Obviously, the separation between the features is more distinct after the projection.

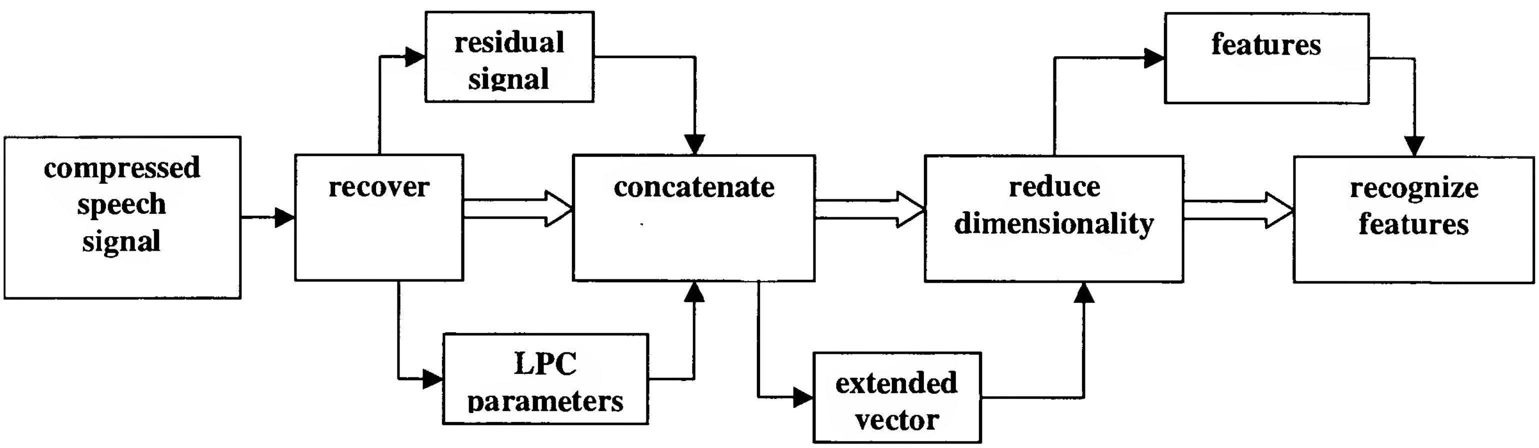
In practice, this LDA can be performed by assuming that the two probability densities $p(\vec{x}|c=1)$ and $p(\vec{x}|c=0)$ have different means and a shared covariance, and then use the maximum likelihood estimate or the maximum a posteriori estimate of the means and covariance. In the present invention as claimed, The observations $\vec{x}$, are linear predictive coding filter parameters and residual signal, and the features to be classified are phones used by a speech recognition engine.

To assist the Examiner in the continued examination of the application and a proper application of the prior art, the Applicants distinguish Hershkovits (U.S. Patent No. 6,003,004).

Hershkovits takes as input a compressed speech signal. A residual signal in the compressed speech signal is used to estimate energy. The energy is used to locate word boundaries. The word boundaries are used to extract LPC parameters from the compressed signal. The LPC parameters are used to calculate features that can be used for recognition, see figure 6 and figure below.



The invention recovers the residual signal and the LPC parameters from the compressed speech signal. The residual signal and LPC parameters are concatenated into an extended vector. The dimensionality of the extended vector is reduced to produce features suitable for recognition, see figure below.



All rejections have been complied with, and applicant respectfully submits that the application is now in condition for allowance. The applicant urges the Examiner to contact the applicant's attorney at the phone and address indicated below if assistance is required to move the present application to allowance. Please charge any shortages in fees in connection with this filing to Deposit Account 50-0749.

Respectfully Submitted,

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